

A
DISSERTATION

ON

THE PROPERTIES OF PUS.

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DISSERTATION
ON THE PROPERTIES OF PUS;

WHICH GAINED THE PRIZE-MEDAL, GIVEN BY THE
LYCEUM MEDICUM LONDINENSE, FOR THE YEAR
MDCCLXXXVIII, AND WAS ORDERED TO BE PRINTED
FOR THE USE OF THE SOCIETY.

Sis
BY EVERARD HOME, F.R.S. *K.*

AND ONE OF THE PRESIDENTS OF THE LYCEUM MEDICUM.

Felix, qui potuit Rerum cognoscere Causas.



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MDCCLXXXVIII.

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DISSEMINATION

ON THE PROPERTIES OF BUS

WHICH GAINED THE FIRST MEDAL GIVEN BY THE
FACULTY MEDICAL LONDON FOR THE YEAR
1853 AND WAS ORDERED TO BE PRINTED
FOR THE USE OF THE SOCIETY.



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INTRODUCTION.

I Shall make no apology for writing the following dissertation, considering it as a duty incumbent on every member of the LYCEUM MEDICUM to promote, to the utmost of his abilities, the purposes of its establishment; and although I may fail in throwing all the necessary light upon the subject, I must content myself with the satisfaction of having done what I conceive to be my duty, and with having paid the only compliment in my power to the PATRONS, and promoters of the Society, by showing an honest ambition to acquire those honours which they have held out as the reward of our exertions.

“ THE PROPERTIES OF PUS; PARTICULARLY
THOSE WHICH DISTINGUISH IT FROM OTHER
SUBSTANCES. THE CASES IN WHICH IT IS
FORMED. THE TIME ITS FORMATION RE-
QUIRES; AND THE EFFECTS IT HAS UPON
THE BODY.”

IN treating of PUS, its properties, and its effects upon the body, as marked out in the thesis, it will not avail much to enter into the opinions of either the ancient or modern authors respecting it; or examine the arguments by which these opinions have been supported, since that would, in some measure, be deviating from the thesis before me, and would lengthen this dissertation much beyond its proper limits, without enlarging, in any degree, our knowledge of the subject. I shall therefore avoid controversy, and endeavour, by

experiments and observations, to investigate the different parts of the subject.

It may not, however, be improper to take notice, that the most generally established opinion of the nature of Pus, was, its being composed of both solids and fluids. It was distinguished by the term, " True, or laudable Pus"; and was supposed to differ materially from a similar discharge called, Mucus. Yet the distinctions between Pus and Mucus have been very ill defined: there was thought to be a difference, in their appearance to the eye; but the principal mark of distinction arose from a breach of surface being believed necessary to the formation of Pus, but not of Mucus; consequently, when there was no breach in the solids, the discharge was only Mucus.

This notion of Pus must have taken its rise from an idea that the solids of the part were broken down into Pus. The physiologists, who formed this theory, cannot, however, be said to have made their distinctions with great accuracy, since the discharge, in consequence of a blister being applied to the surface of

the body, was admitted to be Pus; although in such cases there is no loss of substance, and therefore the discharge should have been called Mucus.

To ascertain the real difference between Pus and Mucus, has been considered an object meriting the attention of some of our most eminent surgeons, although they have not yet been fortunate enough to discover it. This must have arisen from their adhering to the hypothesis which I have mentioned; and which not being founded upon the principles of the animal œconomy, can never explain, satisfactorily, any of the operations in the living body.

The appearance of a discharge produced from the secreting surface of an internal canal, or excretory duct, when the result of common inflammation, is exactly similar to a discharge, in consequence of inflammation, in any other part of the body. The only respect in which they differ, is; that in the one case there is no breach of surface, and in the other there most commonly appears to be one. The one is suppuration alone; the other, suppuration attended by ulceration.

In the present inquiry I shall confine myself to the collecting those properties and circumstances which I consider to have been ascertained respecting Pus; and shall endeavour, by investigating others not so well understood, to render the history of it more complete. I do not mean to take to myself the merit of all the observations contained in this dissertation, many of them being the results of the labours of others, much better qualified than myself for physiological investigation.

Having attended several courses of the physiological and pathological lectures of one of the celebrated Patrons of this Society, and having paid particular attention to his opinions, respecting Pus, I shall avail myself, in the present inquiry, of his observations; and as the view which I mean to take of this subject may, to many, appear new, it will not be amiss to observe, that I shall, through the whole of this inquiry, consider Pus as a fluid, whose formation depends upon a process in the animal œconomy, analogous to glandular secretions.

Although I mean to confine myself to the consideration of those circumstances which are essential to the formation of Pus in a living animal body, yet the opinion of a preternatural degree of heat being produced in inflammation, which has been supposed necessary to the formation of Pus, is at present so prevalent, that it will be necessary, before we enter upon the investigation of our subject, to show the degree of heat which is really found to be present in inflamed parts in different situations in the body.

The heat of inflamed parts has been so well ascertained by Mr. HUNTER, whose experiments on this subject are given in his lectures, that it will not be necessary for me to do more than to give an extract from his lectures on that subject.

EXPERIMENT I.

“An incision was made into the thorax of a dog, about the centre of the right-side, and a thermometer was introduced, with the ball in contact, or nearly so

with the diaphragm, the heat was 101° . The wound was filled with lint, dipped in salve, to prevent its healing, and the whole covered with sticking-plaster: the day following the heat was found to be exactly 101° .

EXPERIMENT II.

The heat of the rectum of a dog, three inches from the anus, was accurately ascertained by a thermometer, and afterwards a solution of corrosive sublimate was injected. The day following the heat was found to be a little increased, but not half a degree, although the inflammation, produced by the corrosive sublimate, was very considerable.

EXPERIMENT III.

The heat of the rectum of an ass, was found, by the thermometer, to be 99° and a half; and several different trials gave the same result. A mixture of

mustard and ginger, in water, was thrown up. In twelve hours the heat was 99° and a half.

EXPERIMENT IV.

A solution of corrosive sublimate was injected into the rectum of the same afs, and in twelve hours the heat of the part was 99° and a half. In twenty hours it was the same. In sixty hours it was increased to 100° . The injection had irritated the rectum so much as to bring on tenesmus, and a discharge of blood.

EXPERIMENT V.

The heat of the vagina of an afs was 100° . A saturated solution of corrosive sublimate was injected. In two hours the heat was 99° . The next day, in the morning, 99° ; and in the evening 100° . The second morning 99° ; in the evening 100° . The third morning 99° ; in the evening 100° .

This experiment was repeated several times on the same ass, and the results were similar. The inflammation was very considerable, and the cavity of the vagina was almost obliterated by adhesions, in consequence of the coagulable lymph thrown out upon its inner surface.

EXPERIMENT VI.

An oblique incision was made into the glutæi muscles of the thigh of the same ass, about two inches in depth: the heat of the bottom of the wound was 100° , which was exactly the heat of the vagina. A plug of wood, two inches long, inclosed in a tin cannula, one inch and a half long, was introduced into the wound, so that the wood projected half an inch beyond the cannula, and filled up the bottom of the wound. They were kept in this situation by means of threads.

The next day, the wooden plug being withdrawn, and the thermometer introduced to the bottom of the wound, through the tin cannula, the heat was found

to be 100° , both in the morning and evening. The second day, the heat of the bottom of the wound, in the morning, only 99° ; in the evening 101° and a half. The third morning 99° ; in the evening 100° .

EXPERIMENT VII.

A wound was made into the abdomen of an afs, and a solution of common salt injected into the cavity, which produced a violent inflammation there. The next morning the heat of the vagina, examined by a thermometer, was 99° and a half; which is nearly the natural heat of that part. In the evening it was increased to 101° and a half. On the second morning the heat of the vagina was 100° and a half, and in the evening the same.

EXPERIMENT VIII.

A man had the operation for the radical cure of the hydrocele, performed at St. George's Hospital, by Mr.

Hunter. When the tunica vaginalis was laid open, the ball of a thermometer was applied to the side of the testicle, its heat was 92° ; the cavity was filled with lint dipped in salve, that it might be occasionally removed, and next day the heat was found to be 98° and three-fourths."

From these experiments it is evident, that the increase of heat which takes place in a part, during the presence of inflammation, however considerable it may appear to our sensations, is no more than bringing it nearer to the standard heat of the source of the circulation; and therefore in parts near the heart, we have no such increase during that process; but in parts at a considerable distance, and in small projecting parts, we find the heat to be increased several degrees.

We cannot therefore admit that any preternatural degree of heat is necessary for the formation of Pus, although the standard heat, or nearly so, of the body, would seem to be required for the full and complete action of inflammation, by which process Pus is formed.

From the above experiments it appears, that the heat present during inflammation is greater than the standard heat laid down by authors: this, however, arises from that standard not having been taken from the heart, but from the superficies of the body, which admits of considerable variation in its heat.

The heat of the rectum is found, from the collected results of a number of different experiments on living animals,* to differ from that of the heart about one or two degrees, it being one or two degrees colder; a knowledge of which fact makes the standard heat of any animal very readily ascertained with a tolerable degree of accuracy.

The rectum of a puppy is 100° of heat; of an ox 99° and a half; of a rabbit 99° and a half; of a man 98° and a half; therefore the standard heat of these animals will be as follows: that of the puppy 101° or

* Vide Mr. Hunter's Observations on certain Parts of the Animal Economy, where a thermometer adapted for experiments of this kind is described.

102°; of the ox 100° and a half, or 101° and a half; of the rabbit 100° and a half, or 101° and a half; of man 99° and a half, or 100° and a half."

IT is difficult to give a definition of any thing, the properties of which are not well ascertained; but as it is necessary that I should particularize the substance which I propose to investigate under the term Pus, I shall define it to be a whitish fluid, made up of globules, and a transparent aqueous liquor. Its production depends upon inflammation having previously taken place in some part of the body, either in the common reticular membrane, upon the internal surface of circumscribed cavities, or the surfaces of internal canals, which I shall call excretory ducts.

Inflammation is necessary for the formation of Pus; and although a fluid, somewhat similar, is produced without any preceding inflammation, such fluid not having all the properties of true Pus, can be readily distinguished from it.

Pus, whether it is formed in the cellular membrane, upon an investing membrane, or on the internal surface of an excretory duct, has exactly the same appearance, and general properties; I shall therefore make no distinctions between Pus produced under this or that peculiar circumstance, believing it, when preceded by the same degree of inflammation in a healthy constitution, and when free from any extraneous substances, to be the same fluid; but, as a difference in Pus may arise, from a variety of causes, I shall endeavour first to mark those properties which really belong to it in a healthy state of body; and afterwards mention the variations to which it is liable.

Pus, taken from a healthy sore, near the source of the circulation, as on the arm or breast, readily separates from the surface of the sore, the granulations underneath being small, pointed, and of a florid red colour, and has the following properties: It is nearly of the consistence of cream; is of a white colour; has a maukish taste; and when cold, is inodorous; but when warm, has a peculiar smell. Examined in the microscope, it is found to consist of two parts, of

globules, and a transparent colourless fluid: the globules are, probably, white, at least they appear to have some degree of opacity: its specific gravity is greater than that of water: it does not readily go into putrefaction: exposed to heat, it evaporates to dryness; but does not coagulate: it does not unite with water in the cold of the atmosphere, but falls to the bottom; yet, if kept in a considerable degree of heat, rises, and diffuses through the water, and remains mixed with it, even after having been allowed to cool; the globules being decomposed.

“ Pus,* poured upon the vitriolic acid, swims on the surface, and no effervescence takes place; but the mixture, upon standing two hours, becomes semiopaque, and of a dark purple colour.

* As the history of Pus might be deemed imperfect, without the chemical combinations and analysis being mentioned, I have given the following investigation, as far as relates to chemistry, from the thesis of Dr. Brugman, who graduated at Leyden in 1787; but as there is nothing contained in many of the experiments which throws much light upon the subject, in the view which I have taken of it, I have only repeated those which appeared to me deserving of particular attention; resting the others wholly upon Dr. Brugman's authority.

Upon Pus being added to the strong nitrous acid, an effervescence takes place, and the mixture becomes green, afterwards pellucid, and then yellow.

Mixed with the phlogisticated muriatic acid, it does not seem at first to unite with it, although some globules of air are let loose; but in the course of two days the mixture becomes an homogeneous ash-coloured mass.

Pus, when mixed with the fixed vegetable alkali in the form of oleum tartari per deliquium, is neither dissolved nor coagulated by it.

With the fixed fossile alkali, in solution, a small portion of the Pus unites with it, forming a milky fluid, and the rest falls to the bottom; upon adding the weak nitrous acid to the solution, the Pus is separated in form of a viscid ash-coloured fluid.

The volatile alkali, in a dry form, if mixed with equal parts of Pus, becomes exceedingly viscid: upon the addition of water, equal to its bulk, the solution is

homogeneous, semipellucid, and white; and is separated by the nitrous acid in form of a viscid white film on the top of the liquor.

Caustic volatile alkali dissolves a considerable portion of Pus, but not the whole of it, forming a very viscid fluid: upon adding water the Pus is separated in form of a mucilage: the same effect is produced by any of the acids.

Caustic fixed alkaline lixivium, wholly dissolves an equal quantity of Pus, forming a very viscid fluid; but, upon adding water, it is all deposited in a viscid form.

Upon adding vitriolic acid to the solution of Pus, in caustic fixed alkali, the Pus is precipitated in form of a white powder: if it is the weak nitrous acid, the Pus is separated in form of flakes, swimming in the liquor: if the muriatic acid, it is separated in form of a viscid film upon the surface.

The neutral salts in solution have no action on Pus; it may, however, be observed, that Pus sinks sooner in them than in water, so that they appear to thicken it.

The earthy salts produce these effects more evidently; and the metallic salts in a still greater degree.

Alcohol condenses Pus by uniting with its aqueous parts; but neither coagulates nor dissolves it.

Pus, when fresh, contains neither an acid, nor an alkali; but being allowed to remain exposed to a moderate degree of heat, it takes on other properties; acquires a pungent smell; it changes the syrup of violets, red; corrodes copper, turning it green, showing signs of an acid quality, from taking on the acetous fermentation.*

The chemical analysis of Pus is as follows: Eight ounces and a half of thick yellowish white Pus, quite

* To ascertain whether Pus turns sour before it putrifies, I exposed some Pus to a moderate heat, and every half hour tried its effects on the syrup of blue violets, but could not procure a red colour, although I repeated the experiment a great number of times: the only change, I could perceive, was to a green. I must therefore suspect that, the acid properties, observed by Dr. Brugman, arose from some accidental circumstance.

fresh, and without smell, distilled in a sand-heat, never raised above 212° , yielded, in the first day, a limpid phlegm, first without any smell; but afterwards the smell of recent warm Pus could be evidently distinguished. The whole quantity, seven ounces, two drachms, nine grains.

This phlegm contained neither an acid nor an alkali; not producing any change on the blue colour of violets; and exposed to heat, evaporated wholly away like distilled water.

After this phlegm, a vapor rose by degrees with an empyreumatic smell. A fresh receiver being applied to the retort, a whitish phlegm, with an ungrateful smell and taste, was collected, in quantity three drachms.

This phlegm turned the infusion of blue violets, green; and formed a white precipitate upon being added to corrosive sublimate; evidently showing, that it contained an alkali; and from the taste it proved to be the volatile alkali. With this phlegm a considerable quantity of air was extricated.

The heat being increased, a little of the dry volatile salt attached itself to the neck of the receiver, which was soon dissolved, and removed by the vapor; nor did the same appearance again occur during the whole of the experiment.

A phlegm with a stronger smell, and a yellowish oil, which, from its weight, fell to the bottom, weighing two scruples, fifteen grains, was collected in another receiver.

The oil was empyreumatic, fluid, and free from acidity; not becoming solid in a moderate cold. The phlegm was found to contain a considerable quantity of volatile alkali.

An oil now began to rise, deeper coloured, exceedingly fetid, and empyreumatic, with a thinner yellow oil, with which it did not mix. The vapor of the volatile salt formed crystals, which attached themselves to the sides of the receiver.

. The heat being now raised till the bottom of the retort was red hot, a mass was obtained of the oil and dry salt, weighing two drachms, one scruple, and fifteen grains. Of this mass, one-fourth part was volatile alkali.

These empyreumatic oils, as far as could be observed, resembled exactly a similar oil obtained from blood.

The retort being cooled, and broken, the caput mortuum was black, light, and shining, weighed three drachms and five grains. This was put into a crucible, and exposed to a violent reverberatory fire for eight hours; there remained eight grains of reddish brown ashes, with an earthy taste, not at all saline. These ashes showed a polarity on the application of the magnet.

The ashes being digested in warm distilled water; the liquor strained and evaporated, no salt could be obtained from them. Upon adding to them vitriolic acid, a small part was dissolved, like calcareous earth;

the greatest part, however, was neither affected by the vitriolic nor nitrous acids."

The above analysis proves, that Pus is composed of the same materials with the blood and animal jelly; and so far they are similar, the same substances being produced from both: a knowledge of the chemical properties, however, gives us little information respecting those properties which distinguish Pus from the other parts of an animal; or from the different secretions.

PUS varies in its appearance, according to the different circumstances which affect the sore that forms it, such as the degree of violence of the inflammation; also its nature, whether healthy or unhealthy; and these depend upon the state of health, and strength of the parts yielding the Pus. These changes arise more from indolence, and irritability, than from any absolute disease: many specific diseases, in healthy constitutions, producing no change in the appearance of the

matter from their specific quality, but by rendering the fore either indolent, or irritable. Thus the matter from a gonorrhœa, from the smallpox pustules, the chicken-pock, and from a healthy ulcer, has the same appearance, and seems to be made up of similar parts, consisting of globules floating in a transparent fluid, like common Pus, the specific properties of each of these poisons being superadded to those of Pus. Matter from a cancer may be considered as an exception; but a cancerous fore is never in a healthy state.

In indolent ulcers, whether the indolence arises from the nature of the constitution, weakness of the parts, or the nature of the inflammation, the Pus is made up of globules, and flaky particles floating in a transparent fluid; and these globules and flakes are in different proportions, according to the degree of indolence: this is particularly observable in scrophulous abscesses, preceded by a small degree of inflammation. That this flaky appearance is no part of true Pus, is well illustrated by observing, that the proportion it bears to the globules is greatest where there is the least inflammation; and in those abscesses that sometimes occur which

have not been preceded by any inflammation at all, the contents are wholly made up of a curdly or flaky substance of different degrees of consistence, which I do not consider as Pus, from its not having the properties stated in the definition of that fluid.

The constitution and part must be in health to form good Pus; for very slight changes in the general health are capable of producing an alteration in it, and even of preventing its being formed at all, and substituting in its place coagulable lymph. This happens most readily in ulcers in the lower extremities, owing to the distance of the parts from the source of the circulation, rendering them weaker. And it is curious to observe the influence that distance alone from the heart has upon the appearance of Pus.

A man had a compound fracture of the right-leg, and an ulcer on the ankle of the left; he was in tolerable health, both the sores looking well. An attack of fever came on soon after, when the ulcer on the ankle ceased to form good Pus, the matter not separating readily from the surface of the sore, while the

compound fracture continued to look very well ; but in twelve hours more the same change had taken place in the fore of the compound fracture, which was about six inches higher up the leg than the ulcer.

The following observation will show how much the appearance of the Pus depends upon the state of the patient's general health. In a large hospital, on the west coast of this island, there were, at one time, twenty men with worn-out constitutions in the same apartment, having large ulcers in different parts of the body. These ulcers, when the weather was mild, dry, and temperate, put on a healing appearance, and formed good matter ; but any sudden change in the weather, either becoming rainy, or damp with fogs, produced so great and sudden an effect on the discharge from those ulcers, as to change it, in the course of twenty-four hours, from a healthy appearance, which had lasted for some time, to the very reverse, the whole ulcer being covered with coagulable lymph, resembling melted tallow spread over it, which could not be separated from its surface.

In irritable sores, the discharge is often thin, being principally made up of an aqueous fluid possessed of an irritating quality, and containing few globules; such sores are commonly attended with hæmorrhage from the smaller vessels, by which means the discharge is very materially altered in its properties, is rendered acrid, and more ready to run into putrefaction than true Pus. We find, however, in many irritable constitutions, the same appearances that were mentioned to take place in the indolent, the coagulable lymph being thrown out, and adhering firmly to the surface of the sore; therefore, the appearance of a sore alone will not lead us to a correct judgment of its nature, but will only inform us whether it is healthy or unhealthy.

Although I have taken notice of these different appearances of Pus, from their being so connected with its history as to deserve attention, I do not consider them as belonging to true Pus; but as arising from a defect in the process, whatever it is, by which Pus is formed.

As Pus has been supposed to have a corroding quality, I made the following experiments to ascertain the truth, or fallacy of such an assertion, and found it to be void of foundation, and to have arisen from the inaccuracy of observers having prevented them from seeing the distinctions between Pus in a pure state, and when mixed with other substances.

EXPERIMENT I.

I made a comparative trial upon matter contained in an abscess, and on Pus and animal jelly out of the body. The matter and jelly were in equal quantities, and contained in glass-vessels kept nearly in the temperature of the human body. To make the comparative trials as fair as possible, a portion of muscle, weighing exactly one drachm, was immersed in the matter of a compound fracture, in the arm of a living man, and a similar portion into some of the same matter out of the body; also a third portion into fluid calf's foot jelly, in which the animal substance was pure, having neither wine nor vegetables mixed with it. These three

portions of muscle were taken out once every twenty-four hours, washed in water, weighed, and returned again. The results were as follows :

In 24 hours—the portion of muscle in the abscess weighed sixty grains, was pulpy and soft, but quite free from putrefaction : that portion immersed in the Pus, weighed forty-six grains, was pulpy, soft, and had a slightly putrid smell : the portion in the jelly weighed thirty-eight grains, was smaller, and firmer in its texture.

48 hours—the portion of muscle in the abscess weighed thirty-eight grains, and had undergone no change : that in the matter weighed thirty-six grains, was softer, and more putrid : that in the jelly thirty-six grains and smaller.

72 hours—the portion of muscle in the abscess weighed twenty-seven grains, was drier, and firmer : that in the matter eighteen

grains, and was rendered fibrous and thready : that in the jelly unaltered.

In 96 hours—the portion of muscle in the abscess weighed twenty-five grains : that in the matter was dissolved : that in the jelly weighed thirty-six grains.

120 hours—the portion of muscle in the abscess weighed twenty-two grains, not at all putrid : that in the jelly thirty-four grains, not at all putrid.

144 hours—the portion of muscle in the abscess weighed twenty-two grains, and was free from putrefaction : that in the jelly thirty-four grains.

The next day the jelly had evaporated to dryness, which put an end to the comparative experiment. The portion of muscle in the abscess was kept there a few days longer, without undergoing any change or dimi-

nution of weight ; and was taken out, in consequence of the arm requiring fomentation, which interfered with the experiment.

EXPERIMENT II.

A similar experiment was made upon the matter contained in an abscess recently opened, where the Pus was not pure, but mixed with blood from the cut edges of the external opening, which had not come to suppuration.

A portion of recent muscle, weighing one drachm, was immersed in the abscess ; and a similar portion in a small vessel of water, of nearly the temperature of the human body.

In 24 hours—the portion of muscle in the abscess weighed twenty-four grains, and was very putrid: that in the water forty grains, rendered smaller, but free from putrefaction.

In 48 hours—the portion of muscle in the abscess was wholly dissolved: that in the water weighed thirty-eight grains.

This circumstance alone of Pus, when in a pure state, not readily taking on the putrefactive fermentation, distinguishes it from those fluids which are not perfect substances, but a mixture, which Pus must be reckoned, in these instances, where it has extraneous parts mixed with it; and likewise distinguishes it from the produce of fermentation of animal or vegetable substances, as they run very readily through all the different stages of fermentation, that process being once begun.

The property which characterizes Pus, and distinguishes it from most other substances, is, its being composed of globules. This appears to me to throw considerable light upon the subject; since the presence of the globules seems to depend upon the Pus being in a perfect state; from which we learn the circumstances necessary for the production of good Pus. Mr. Hunter was, I believe, the first who took notice

of this property ; and has thereby furnished us with a very accurate distinction between Pus and animal mucus. For the appearance of what is properly termed Mucus, that is, animal substance dissolved from putrefaction, is flaky, and very different in its appearance from Pus. It is also by this property distinguished from all the chemical combinations of animal substance that I am acquainted with ; every one of which appear in the microscope to be made up of flakes.

At the same time that this appearance in the microscope distinguishes Pus from other substances, it shows its great affinity to the other animal secretions, although in many circumstances it differs from them.

It differs from the blood in the colour of the globules ; in their not being soluble in water, which those of the blood are ; and from the fluid in which they swim being coagulable by a solution of sal ammoniac, which serum is not.

The observation of, "The fluid in which the globules of Pus are contained, being coagulated by a solution of sal ammoniac," is not taken from the results of Dr. Brugman's experiments; but from the following, made by Mr. Hunter, prior to the publication of Dr. Brugman's Thesis.

EXPERIMENT III.

"A drop of matter, and a drop of blood, were placed upon a piece of glass, at a small distance from each other, and the glass was fixed under the magnifying lens of a microscope: while in this situation, the point of a toothpick was dipped in a saturated solution of sal ammoniac, and applied to each of them. This was repeated two or three times. The drop of matter, instead of appearing more diluted, became viscid and ropy; and upon being examined through the magnifying glass, the globules appeared perfectly distinct in the coagulum.

The drop of blood had no appearance of coagulation; on the contrary, it was more diluted.

This experiment was repeated several times, and the results were always similar."

Pus differs from chyle, in its globules being larger; not coagulating by exposure to the air, nor by heat, which those of chyle do.

The pancreatic juice contains globules; but they are much smaller than those of Pus.

Milk is composed of globules, nearly of the same size as those of Pus; but much more numerous. Milk coagulates by runnet; which Pus does not; and contains oil and sugar, which are not to be discovered in Pus.

THE cases in which Pus is formed, are, properly speaking, all reducible to one, which is, The state of

parts consequent to inflammation. For as far as I yet know, the fluid which I have considered as Pus, in this dissertation, has, in no instance been met with, unless preceded by inflammation; and although, in some cases, a fluid has been formed, independent of preceding inflammation, it differs from Pus in many of its properties, as has been already observed.

Inflammation appears not only to be the forerunner, but the absolute cause of the formation of Pus; and there are some facts which furnish strong arguments in favour of the ingenious idea Mr. Hunter has suggested in his lectures; "That the vessels of the part take on the nature of a gland and secrete a fluid which becomes Pus."

The facts are as follows: In inflammation, the smaller blood-vessels become considerably enlarged; and what is curious, this takes place in the greatest degree in the veins; the small vessels are not only enlarged, but become more numerous; which does not proceed entirely from the blood being propelled further than usual in the old vessels, but from new ones being

formed; and this takes place in a much shorter time than has been commonly imagined. It is highly probable, that these new vessels are so constructed, as to make the blood undergo certain changes, by which the fluid, that afterwards constitutes Pus, is formed.

It has been long discovered, that new vessels are generated in extravasated coagula of blood, and exudations of coagulable lymph; and this fact is well illustrated by many specimens, in the collection of diseased parts, exhibited by Mr. Hunter at his lectures. But the following case ascertains the period in which this effect can be produced to be within twenty-four hours. And we know that Pus commonly requires a much longer time for its formation under the same circumstances, and in similar parts.

I performed the operation for the strangulated hernia, upon a man, in other respects in health, at seven o'clock in the morning. The hernial sac was laid open, and the gut, which proved to be a portion of the ilium, about six inches in length, was attentively examined previous to its being returned into the cavity of the

belly: it had the natural polished surface, peculiar to an intestine; and although its vessels were turgid with blood, it did not appear that they were uncommonly numerous. After the operation, the symptoms did not abate so much as might have been expected; and, during the afternoon, he complained of pain in the lower part of his belly: he had no passage by stool; and next morning, about seven o'clock, his pulse was scarcely perceptible to the touch; his skin cold and clammy; and about twelve at noon he died, having lived twenty-nine hours after the operation.

The body was opened, and the portion of gut, which had been strangulated, was found considerably inflamed; the external surface having lost its natural polish, and having several small portions of exuded coagulable lymph adhering to it. The vessels of the gut were minutely injected, the arteries with a red coloured injection, and the veins with a yellow one. Upon examination, afterwards, all these adhering portions of coagulable lymph were found to be injected, having a considerable artery going to each of them, and a returning vein which was larger than the artery. It is

evident, therefore, that the coagulable lymph was laid upon the external surface of the gut after the operation: and we cannot suppose, that any such process as the forming of new vessels, could have been going on during the last five hours of his life, when the pulse in the wrist was scarcely to be felt, and the powers of life were so much weakened in every respect. We must therefore conclude, that the whole operation of throwing out coagulable lymph, and supplying it with blood-vessels after it had become solid, was effected in less than twenty-four hours.

This shows, that inflammation forms a vascular surface upon which Pus is afterwards deposited. Is it not, therefore, highly probable, that the newly formed parts are so organized as to secrete that fluid?

IN considering the time required for the formation of Pus, I shall first take notice of the periods which are found, under different circumstances, to intervene between a healthy or natural state of the parts, and

the presence of that fluid after the application of some irritating substance to the skin.

In cases of wounds made into muscular parts, where blood-vessels are divided, the first process which takes place, is the extravasation of red blood; the second, is the exudation of coagulable lymph, which afterwards becomes vascular; and the third, the formation of matter, which last does not, in common, take place in less than two days: the precise time will, however, vary exceedingly, according to the nature of the constitution, and the state of the parts at the time.

If an irritating substance is applied to a cuticular surface, upon which it raises a blister, Pus will be formed in about twenty hours, as we find in the following experiment.

EXPERIMENT I.

I applied a blistering plaster, the size of a half-crown piece, to the pit of the stomach of a healthy young man. In eight hours a blister rose, which was

opened, and the contents removed; they were fluid, transparent, and coagulated by heat; had no appearance of globules when examined by the microscope; and in every respect resembled the serum of the blood. The cuticle was not removed; but allowed to collapse; and the fluid, which was formed upon the surface of the cutis, was examined from time to time, by a microscope, to detect, as accurately as possible, the changes which took place. The better to do this, as the quantity in the intervals stated below must be exceedingly small, a piece of talc, very thin and transparent, was applied to the whole surface, and covered with an adhesive plaster; and the surface of the talc, applied to the skin, was removed and examined by the microscope, applying a fresh piece of talc after every examination, to prevent any mistake which might have arisen from the surface not being quite clean.

The fluid was examined by the microscope, to ascertain its appearance; but as the aqueous part in which the globules of Pus swim, is found, by experiment, to coagulate, by adding to it a saturated solution of sal ammoniac, which is not the case with the serum of the

blood, nor the transparent part of milk, I considered this as a property peculiar to Pus; and consequently that it would be a very good test by which to ascertain the presence of true Pus.

In 8 hours—from the time the blister was applied, the fluid discharged was perfectly transparent, and did not coagulate with the solution of sal ammoniac.

9 hours—the discharge was less transparent; but free from the appearance of globules.

10 hours—the discharge contained globules, which were very small, and few in number.

11 hours—the globules were numerous; but still the fluid did not coagulate with the solution of sal ammoniac.

12 hours—the appearance much the same as before.

In 14 hours—the globules a little larger; and the fluid appeared to be thickened by a solution of sal ammoniac.

16 hours—the globules seemed to form themselves into masses; but were transparent.

20 hours—the globules were double the size of those first observed at ten hours, and gave the appearance of true Pus in a diluted state: the fluid was coagulated by a solution of sal ammoniac; the globules, at the same time, remaining perfectly distinct; so that I should consider this as true Pus.

22 hours—no change appeared to have taken place.

32 hours—the fluid was considerably thicker in consistence, the number of globules being very much increased: but in no other respect, that I could observe, did

it differ from that formed twenty hours after the application of the blister.

As the results of microscopical experiments have been found exceedingly fallacious, a prejudice has very naturally arisen against all experiments of this kind, upon the secretions of the human body, from a supposition that they are not to be depended upon. But it is right that we should discriminate, and not condemn the use of the microscope altogether, because, from ignorance of its principles, it has been misapplied; since these very deceptions have been the means of our acquiring a more accurate knowledge of the use and application of that instrument.

The errors, in the use of the microscope, have arisen from increasing the magnifying powers of the glasses too much, and not taking in all the circumstances relating to the refraction of the rays of light; making no allowance for the aberration. An attention to the aberration alone will explain the different appearances under which the red globules of the blood have been represented. Some have found them perfect spheres;

which will always be the case when the glasses are perfectly adjusted, and the object placed at the true focal distance. Others have found them annular, from the object being at the focal distance of the rays transmitted near the circumference of the magnifying glass, which are refracted in a greater degree, and consequently shorter than the central rays. Others again have viewed them as flattened bodies of a circular figure, bright in the centre, and becoming darker towards the edges; which appearance arises from the object being at the focal distance of the central rays of the magnifying glass, which will be less refracted than those near the circumference. Although such are the errors which arise when microscopical researches are pushed beyond certain bounds; yet that the red part of the blood is made up of globules, is a discovery for which we are indebted to the microscope; and which seems to be as well ascertained as any discovery in anatomy or physiology. The appearances of Pus, mentioned in this paper, are equally distinct, when examined on the field of a microscope, as the globules of the blood; are visible with a small degree of mag-

nifying power; and are the same to the eyes of different persons.

The time required to form Pus, on a secreting surface, appears, from the following experiment, to be five hours.

EXPERIMENT II.

A common bougie, four inches long, was introduced into the urethra of a healthy young man. The surface of the bougie was not oiled, which made the irritation more violent, and prevented there being any ambiguity in the appearance of the fluid collected upon it.

In $\frac{1}{2}$ an hour—the bougie was withdrawn, and the fluid on its surface, examined by the microscope, was found to contain globules that were very small, and few in number, resembling those found under the cuticle in the blister at ten hours. The bougie was again introduced.

In 1 hour—the fluid had the same appearance.

In 1 hour and $\frac{1}{2}$ —the globules larger and more numerous.

3 hours—the globules more numerous.

4 hours—the globules larger ; but the fluid did not coagulate with the solution of fal ammoniac.

5 hours—the globules large and numerous : the fluid coagulated with the solution of fal ammoniac. I therefore considered it as true Pus.

To prosecute this inquiry still further, I endeavoured to ascertain the changes this fluid undergoes from the time of its leaving the extremities of the vessels which form it, till it becomes that thick fluid we find upon suppurating surfaces, called Pus.

In this investigation it is necessary to attend to the following circumstances : That a suppurating surface,

upon exposure, does not form Pus, but a watery fluid, similar to what is thrown out in consequence of the irritation of cantharides, which, from its coagulating by heat, is most probably serum; and, that pressure, from a hard substance, acts as an irritator, and produces a similar effect to exposure. These circumstances rendered ineffectual several trials which I made, to collect the matter from a healthy fore, on pieces of glass.

After several unsuccessful trials, in different ways, to collect the fluid in the various states of its formation, I used small pieces of very fine lamellæ of talc; which, although hard substances, were, from their extreme thinness, very light; and, having a smooth polished surface, gave less irritation than any other substance that I could devise. One circumstance which renders them fit for these experiments, is, that the fluid being in very small quantity, and from that circumstance drying almost immediately, there is no time for removing it from the surface upon which it is collected, to another, for examination.

The experiments were made upon a healthy granulating sore, on the upper surface of the prepuce of a healthy young man, about two inches square, forming good Pus.

EXPERIMENT III.

I exposed the surface of the sore; wiped it dry, and applied a piece of talc upon one part of it, leaving the rest exposed. The surface of the talc was almost immediately covered with a thin fluid. This, in about three minutes, was removed and examined by the microscope: it appeared to be transparent; and although examined for some time, did not change in any respect from the appearance it at first exhibited.

This experiment proves that, the fluid, formed during exposure, is not Pus at the time of its formation; and that it afterwards goes through no changes which give it the least resemblance to that fluid.

EXPERIMENT IV.

I wiped the sore, and applied four very small pieces of talc upon different parts of it; immediately afterwards covering the whole with a plaster of common cerate, spread upon lint, to take off the effects of exposure.

In 5 minutes—I removed one of the pieces of talc, and examined the fluid on its surface; which appeared like a thin transparent jelly, divided into masses; but in which no globules could be distinguished.

10 minutes—another piece was examined, and the appearance was like the former. But, at the bottom, a number of small globules could be readily discerned.

15 minutes—a third piece was examined, and the whole mass appeared to be made up of small globules; but these were almost

transparent, and seemed to become more distinct and opaque while looking at them.

In 20 minutes—I examined the fourth piece, and the globules were found more numerous and opaque, like those of common Pus.

From this experiment we find that Pus, at its formation, is not globular; but a transparent fluid, of a consistence, in some sort, resembling jelly; and that, the globules are formed while lying upon the surface of the sore; requiring, in some instances, while the influence of external air is cut off, fifteen minutes for that purpose.

To see how far the formation of the globules depended upon the fluid remaining in contact with the granulations, I made the following comparative experiment.

EXPERIMENT V.

The fore being exposed and wiped dry, I applied, to different parts of its surface, two pieces of talc, and covered the whole as in experiment IV. In five minutes, I removed one piece, and found the transparent fluid, mentioned above; but no globules. I then covered the surface of the talc, on which the fluid lay, with another piece of talc, to prevent the fluid coming in contact with the granulations, and applied it again to the fore. In twenty-five minutes more, I examined it by the microscope; as also the fluid upon the other piece of talc, which had remained thirty minutes upon the fore, and found, in both of them, the globules distinct and very numerous; but most so upon the portion of talc in contact with the fore.

This proves that, after the fluid is once separated from the vessels, its becoming globular is a change taking place within itself, independent of the fore which secretes it.

EXPERIMENT VI.

I applied a piece of talc, as before, and covered the whole fore for two minutes; I then removed the piece of talc, and examined its surface by the microscope: at first, no globules appeared. The examination was continued five minutes; in which time the globules became exceedingly distinct to my own eye, and to the eye of another person well versed in microscopical experiments.

This experiment I repeated several times; but the quantity of fluid was in general so small, that it evaporated to dryness before the change into globules took place.

From this last experiment, it is not only evident that the globular appearance of matter is a change that takes place in the fluid after it is secreted; but it further proves, that the globules are formed in a much shorter time when the fluid is exposed, than when kept from the air. And, I think, we are led, from the

whole of these experiments, to conclude that, the time required for the formation of Pus, in the state we commonly find it upon a healthy sore, varies according to circumstances, and is from five minutes to twenty.

IN treating of the effects which matter produces on the body, I shall consider it as essential to the formation of granulations in wounds which are kept from healing by the first intention or adhesions, and to the filling up of cavities which are exposed. But what the particular effects are, by which Pus either gives rise to, or assists the process of forming granulations, I must confess myself to be entirely ignorant. Nor am I acquainted with any effect which it produces on the parts that formed it, or upon the constitution, believing that all the effects which are attributed to matter, do not arise from any property in the matter, as Pus; but are in consequence of some extraneous substance being mixed with it; or, some morbid affection of the parts which form it. And this observation is equally true, whether we consider its effects locally or constitutionally.

Although Pus frequently produces considerable local effects upon the neighbouring parts, it never affects the surface which formed it: this arises from the parts themselves not being susceptible of irritation from their own matter; which may be illustrated by several of the secretions, and morbid poisons.

Absorption of matter has long been considered as the cause of many diseases; but this opinion seems to be done away by the late advancements in physiological knowledge: and indeed the effect is not sufficiently general to arise from such a cause; since instances of matter being absorbed, occur daily, where no ill consequences whatever are produced in the constitution.

Among the diseases which have been considered as consequent to absorption, the principal are, a general wasting of the body, hectic fever, and diseases of the lungs.

That such complaints do frequently occur in patients who have a considerable discharge of matter from large abscesses, or sores, is a fact that every one will admit;

but if the length of time the local complaint has continued, and the injuries which the constitution has sustained from it, be likewise taken into the account, with all the other attending circumstances at the time the consequent disease is produced, it will appear that we cannot, with justice, attribute its origin to the absorption which has been equally present through the whole time ; but must refer it to the debilitating effects of a long continued discharge, or a constant irritation, preying upon the constitution, and in the end becoming the cause of constitutional diseases.

FROM the whole of the foregoing investigation, I think the opinion started by Mr. Hunter, " Of Pus being a secretion ; or, at least, a fluid formed from a similar structure of vessels, as the secretions from the blood," appears to be a just one ; and I very willingly confess, in justice to that celebrated physiologist, that I have been led to the view which I have taken of this subject, from the observations respecting Pus, contained in his lectures.

I shall briefly state the arguments which appear to have most weight, in support of Pus being a secretion from the blood.

In its chemical analysis, it is found to contain similar substances with the blood.

It is, in a recent state, free from any tendency to putrefaction.

It is always in harmony with the parts which form it, having no power of irritating them, even when the surrounding parts are affected by it. This seems to be peculiar to secretions; and may be illustrated by the tears excoriating the cheek, although no such effect is produced on the lacrimal gland or ducts.

Its appearances vary according to the state of the constitution at the time; and are affected by very slight changes in the general habit, similar to secretions; which could not be the case were it only made up of the solids and fluids of the part.

It is readily absorbed or taken back into the circulation, without producing any ill effect upon the constitution.

The parts which form it assume a structure similar to that of a gland, by becoming exceedingly vascular: and what is curious, and deserving of observation, is, that parts appear to require more time to be rendered fit for carrying on this process, in proportion as they are different in structure from a gland. In internal canals, which have naturally a secreting surface, Pus is formed in five hours. On the cutis, which is very vascular, in less than twenty hours. And in common muscles, nearly in forty-eight hours.

It is composed of globules swimming in a transparent fluid; which is the case with many secretions.

It is thinner at the time of leaving the vessels than afterwards, similar to secretions in general.

I made several attempts to ascertain whether those secretions in which there are globules, really leave the

ends of the vessels in that form, or acquire it afterwards, similar to Pus. But the structure of glands, in general, is such, that I have been unable to devise any method of collecting the secretion immediately upon its leaving the secretory vessels before it is carried along the excretory duct, which must be done to ascertain its nature at the time of its formation.

It is, however, highly probable, from what we know of the secretions in general, that they must, in every instance, leave the terminations of the secreting vessels in a very fluid state; and must take on the consistence they are found to possess, either immediately, or soon after they are secreted, similar to Pus.

THE END.

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